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(Coleoptera (occ. Pine Spp & mtn. Pine Beetle))

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RESEARCH PROGRAM
STUDY PLANS
LINE PROJECT PNW 2201

U. S. DEPARTMENT OF AGRICULTURE - FOREST SERVICE
PACIFIC NORTHWEST FOREST AND RANGE EXPERIMENT STATION
DIVISION OF FOREST INSECT RESEARCH

Work Plan for Exploratory Studies
Season of 1963

OREGON PINE IPS AND MOUNTAIN PINE BEETLE

Portland, Oregon
June 15, 1963

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STUDY PLAN APPROVAL

TITLE: Exploratory studies of the Oregon pine ips and mountain pine beetle, season of 1963.

LINE PROJECT: PNW 2201

LOCATION: Ponderosa pine region, central Oregon.

Author's signature Charles Santwell, Jr.

Date June 1, 1963

	Date	Signature
REVIEWED BY:	June 5, 1963	K H Wright Project Leader Forest Service, PNW Sta.
RECOMMENDED BY:	June 10, 1963	K H Wright Project Leader Forest Service, PNW Sta.
APPROVED BY:	June 10, 1963	R. L. Furniss Division Chief Forest Service, PNW Sta.

SUMMARY:

This work plan describes several exploratory studies which will be made in 1963 as a step in developing future formal investigations on the Oregon pine ips, Ips oregoni, and the mountain pine beetle, Dendroctonus monticolae. To be studied this season are the seasonal histories of I. oregoni and D. monticolae, the effects of changes in sex ratio on I. oregoni attack behavior and brood productivity, and the relationship of seasonal period of ponderosa pine radial growth to success of forced I. oregoni attacks.

OREGON PINE IPS AND MOUNTAIN PINE BEETLE INVESTIGATIONS

Work Plan for Exploratory Studies, Season of 1963

by

C. Sartwell, Jr., Entomologist

INTRODUCTION

Described in this work plan are several exploratory studies to be undertaken in 1963 by the Pacific Northwest Forest and Range Experiment Station, Division of Forest Insect Research, on the Oregon pine ips, Ips oregoni Eichh., and the mountain pine beetle, Dendroctonus monticolae Hopk. One formal study, on ips brood productivity in thinning slash, is to be described in a separate study plan. 1/ These plans describe the first research to be done in several years on pine bark beetles in Oregon and Washington.

The studies to be undertaken were selected from a lengthy list of needed investigations as determined in problem analyses of the two insects. The analyses are in draft form and will be completed within the next year. The 1963 exploratory studies will be helpful in preparing the analyses in final form, particularly in respect to establishing study priorities for future years.

OREGON PINE IPS

Study Io-1. Seasonal History of the Oregon Pine Ips in Central Oregon.

Objective: To determine the seasonal history of Ips oregoni in several central Oregon localities during 1963.

Justification: Before regulation of I. oregoni populations can be achieved, detailed knowledge of the insect's seasonal history must be obtained. Presently, the seasonal history of the Oregon pine ips is known only in general terms, which do not provide a sufficient base for developing practical and effective means of preventing ips killing of living trees. It is known that the beetle's seasonal history in the Pacific Northwest varies by area and year; however, precise knowledge of the variation is lacking. How seasonal history is related to general climatic conditions is also not well known. Therefore, this study is directed toward determining and understanding the seasonal history of

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1/ Wright, K. H., and C. Sartwell, Jr. 1963. Relationship of ponderosa pine thinning slash quality to brood productivity of the Oregon pine ips, study plan. Pacific N. W. Forest & Range Expt. Sta. (in preparation).

I. oregoni in different areas of central Oregon during 1963. Ultimately the data obtained in 1963 will be compared with data from other years to allow a better understanding of seasonal history variation between seasons.

Study Areas and Methods: Seasonal history investigations will be conducted in the following areas: (1) Wildhorse Creek, Fremont National Forest, (2) Pringle Falls, Deschutes National Forest, (3) Canyon Creek, Deschutes National Forest, (4) Hehe Butte, Warm Springs Indian Reservation, and (5) Cove Spring, Malheur National Forest. Details of study methods follow:

A. Field examinations were made during April to determine I. oregoni overwintering stages and sites.

B. During April and May field examinations were made in all areas to determine the approximate dates of the main attack flight period by overwintered adults.

C. In June, recently attacked logs were placed in cages set up in each study area.

D. Caged populations will be maintained throughout the season by collecting adults emerging from infested materials and introducing them into cages containing fresh, uninfested ponderosa pine materials.

E. Accurate emergence and development records will be kept for caged populations.

F. Frequent examinations will be made of non-caged infested materials in the field, and data obtained compared with that for the caged populations.

G. A hygrothermograph will be maintained throughout the field season near the Pringle Falls rearings to provide data for analyzing the relationship of ips seasonal history to general climatic conditions.

H. U. S. Weather Bureau records will be used for analyzing the relationship of ips seasonal history to general climatic conditions in the other study areas, and in the Pringle Falls area for the period not covered by hygrothermograph records.

I. Because time and travel limitations will prevent the project entomologist from regularly maintaining caged rearings in the Wildhorse Creek and Cove Spring areas, some assistance in maintaining rearings will be sought from personnel on the Fremont and Malheur National Forests.

Study Io-2. The Relationship of Sex Ratio to Attack Behavior and Brood Potential in the Oregon Pine Ips.

Objectives:

A. To determine the relationship of sex ratio to attack behavior in Ips oregoni.

B. To determine the relationship of sex ratio to brood potential in Ips oregoni.

Justification: Qualitative change in I. oregoni populations might explain some "ips years" (seasons in which the normally slash-breeding ips attack and kill large numbers of standing, green trees). One of the easiest-to-measure qualities of ips populations is sex ratio. It is also a quality in which some potential for change exists, as is evidenced by the usual change from 1.2 females to each male at emergence to approximately 3 females to each male at attack. 2/ Does a greater change ever occur? Are ips attacks on standing, green trees made by ips populations in which sex ratio differs greatly with that of slash-attacking populations? Is the capacity of I. oregoni to overcome living trees increased by the presence of large numbers of females? Will ips females make attacks in the scarcity or absence of males, which normally make initial attacks? Is brood productivity affected where the attacking population is essentially composed of females? These questions seem worthy of answering, and this study is an attempt to provide the answers.

Study Areas and Methods: This study will be conducted principally in the Pringle Falls area; however, one aspect will be conducted in the Calamity Butte area, Malheur National Forest.

A. The following procedures will be used to determine sex and sex ratios.

1. In an emerging population, sex of each beetle will be determined by the character of its frontal sculpture 3/ and declivital spinature, 4/ and sex ratio will be determined by counting the number of each sex.

2/ Rust, Henry J. 1935. Final report on the biology of Ips oregoni and associated insects of Idaho. Forest Insect Laboratory, Coeur d'Alene, Idaho. 71 pp., illus. (unpublished).

3/ Lyon, R. L. 1955. A secondary sex character on the male of the California five-spined engraver, Ips confusus (Lec.) (Coleoptera: Scolytidae). Canad. Ent. 87:482-483, illus.

4/ Rust. Ibid.

2. In an attacking population, sex will be determined by examining parent galleries rather than beetles, and sex ratio will be determined by counting the number of nuptial chambers and egg galleries.

B. Based upon information gathered in the ips seasonal history study at Pringle Falls to time field examinations, emergence and attack sex ratios will be determined for each of the principal flights of I. oregoni in the Pringle Falls area.

C. The attack sex ratio will be determined for the ips population which killed large numbers of trees in the Calamity Butte area during 1962, to provide information as to whether sex ratio of ips attacking living trees differs with sex ratio of ips attacking slash.

D. To determine if the capacity of I. oregoni to overcome living trees is increased by the presence of large numbers of females, and to determine whether I. oregoni females will make attacks when males are scarce or absent, special cages will be placed around living ponderosa pines, and small ips populations with manipulated sex ratios will be introduced. One set of introductions will be made during each of the following months. June, July, and August.

1. The following cagings will be studied:

   a. Unmated females (new beetles extracted from logs just prior to brood emergence) and males, with sex ratios of 1:1, 3:1, 9:1, 24:1, and 99:1.

   b. Mated (parent) females and males, with sex ratios as above.

   c. Unmated females only.

   d. Mated females only.

2. Two weeks after the ips are introduced the trees will be felled and the bark removed from the caged portions of the boles.

   a. The success of introduced ips will be determined.

   b. For successful attacks, the number of nuptial chambers and female galleries will be counted and the actual attack sex ratio calculated.

E. The effects of sex ratio on brood productivity, and whether emergent parent females need to mate again before establishing an additional brood, will be studied by introducing small ips populations with manipulated sex ratios into cages containing fresh, uninfested ponderosa pine bolts.

1. The following cagings will be studied:

a. Unmated females and males, with sex ratios of 1:1, 3:1, 9:1, 24:1, and 99:1.

b. Mated females and males, with sex ratios as above.

c. Unmated females only.

d. Mated females only.

2. The total number of beetles emerging from each caging will be recorded.

3. After emergence is completed the test bolts will be removed from the cages and debarked to obtain information on character of parent and larval galleries.

Study Io-3. The Relationship of Seasonal Changes in the Physiological Condition of Ponderosa Pine to the Success of Forced Attacks by the Oregon Pine Ips.

Objectives:

A. To determine the relationship of radial growth and oleoresin exudation pressure to season of year and amount of soil moisture.

B. To determine how success of forced Ips oregoni attacks is related to radial growth and oleoresin exudation pressure.

Justification: A frequently offered hypothesis as to why I. oregoni kills ponderosa pine in large numbers only in certain years, is that the species is capable of killing living pines only when tree resistance has been greatly lowered.

In years when ips killing is common, the killing largely occurs late in the summer, 5/ a period during which ponderosa pine radial growth activity

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5/ Buckhorn, W. J. 1942. Preliminary report on the relation of logging operations to outbreaks of Ips oregoni in ponderosa pine forests. Forest Insect Lab., Portland, Oregon. 20 pp., illus. (unpublished).

greatly tapers off 6/ and during which oleoresin exudation pressure becomes lowest. 7/ Late summer is also the time when soil moisture reaches its lowest level. It is believed that both the seasonal length of the radial growth period and the late summer lowering of o.e.p. are related to soil moisture depletion.

The thought here is that ips killing of green trees does not occur in most years because the intensity of radial growth activity and of oleoresin exudation is sufficiently high for the pines to be resistant to ips attacks. And, conversely, in years when ips do kill large numbers of pines, that the ips attacks are successful because seasonal growth is completed or nearly completed and o.e.p. lowered below the critical level prior to the main ips flight in late July and August.

Study Areas and Methods: This study will be conducted on the Pringle Falls Experimental Forest.

A. Aluminum band dendrometers will be installed on 10 trees in early June and weekly measurements made until September 15.

B. Pressure gages will be installed on 3 trees in early June and weekly o.e.p. measurements made until September 15.

C. Soil moisture in the study area will be determined weekly from early June until September 15 by use of a nuclear-probe instrument, available at the Bend Silviculture Laboratory.

D. To determine host susceptibility, forced attacks of I. oregoni males will be made on 5 trees each week from early June until September 15.

1. The beetles will be introduced by either pinning gelatin capsules, each containing a single male ips, to the bark of trees, or by placing male beetles in small excavations in the bark and then covering the excavation with a piece of fine-mesh screen.

2. Two days after the introductions are made the gelatin capsules, or pieces of screen, will be removed.

3. During the following week when the next set of forced attacks are made, the test trees will be examined to determine the success or failure of the introduced beetles and to determine if their activities attracted other beetles to the test trees.

6/ Fowells, H. A. 1941. The period of seasonal growth of ponderosa pine and associated species. Jour. Forestry 39:601-608.

7/ Vité, J. P. 1961. The influence of water supply on oleoresin exudation pressure and resistance to bark beetle attack in Pinus ponderosa. Contrib. Boyce Thompson Inst. 21:37-66, illus.

MOUNTAIN PINE BEETLE STUDIES

Study Dm-1. Seasonal History of the Mountain Pine Beetle in Central Oregon.

Objective: To determine the seasonal history of Dendroctonus monticolae in ponderosa pine in central Oregon during 1963.

Justification: Studies in areas outside the Pacific Northwest show the mountain pine beetle seasonal history to vary in different regions in the same season 8/ and in the same region in different seasons. 9/ Basic to future biological and control studies of D. monticolae in the Pacific Northwest is an understanding of the beetle's seasonal history and its variability in the different areas within the region. Such an understanding is lacking because past studies have been too few, and have been conducted only in the southern Cascades of Oregon and in southwestern Oregon. Furthermore, those studies were with hosts other than ponderosa pine and were done without an awareness of the habit of attacking parent females to emerge and establish additional broods. Accordingly, additional information on the seasonal history of the mountain pine beetle in this region is needed. To satisfy a portion of this need, investigations will be conducted in ponderosa pine in central Oregon during 1963.

Study Methods: This study will be conducted under caged conditions on the Pringle Falls Experimental Forest and in other areas where feasible. Whenever possible, field examinations will be made to compare seasonal history of wild populations to that of the caged population. Specific steps in the study are as follows.

A. Prior to the first flight of wild populations, infested ponderosa pine bolts will be placed in outside cages at Pringle Falls.

B. Daily records of beetle emergence will be kept.

C. Emerged beetles will be collected and then introduced into cages containing fresh, uninfested ponderosa pine bolts to maintain a caged population throughout the season.

D. At the end of the field season, infested material will be identified, placed in outdoor cages, and left at Pringle Falls to be used in a study of the 1964 seasonal history.

8/ Evenden, James C., W. D. Bedard, and G. R. Struble. 1943. The mountain pine beetle, an important enemy of western pines. U. S. Dept. Agr. Cir. 664, 25 pp., illus.

9/ Reid, R. W. 1962. Biology of the mountain pine beetle, Dendroctonus monticolae Hopkins, in the east Kootenay region of British Columbia. I. Life cycle, brood development, and flight periods. Canad. Ent. 94:531-538, illus.

Study Dm-2. Survey of sites for long-term mountain pine beetle host relationship studies.

Objective: To locate suitable sites for long-term studies of the host relationships of Dendroctonus monticolae in pole stands of Pinus ponderosa.

Justification: Now that more than 60 percent of the ponderosa pine acreage in the Pacific Northwest has been cut over, 10/ the attention of forest managers is turning from old-growth virgin stands to young, second-growth stands. The Northwest Forest Pest Action Committee recognizes the mountain pine beetle as one of the foremost entomological obstacles to effective management of young ponderosa pine stands, and advises the undertaking of long-term studies to determine management practices for beetle control. 11/

A long-term study of mountain pine beetle damage in young ponderosa pine stands will be initiated in 1964; because of its extended nature, it is considered important that special attention be paid to the selection of suitable study sites. Accordingly, reconnaissance surveys will be conducted during 1963 for that particular purpose.

Study Methods: Surveys will be conducted by the project entomologist and the project leader to find study areas as follows:

A. Study areas will be sought in these general locations within the region:

1. Okanogan or Wenatchee National Forest.

2. Yakima Indian Reservation.

3. Umatilla National Forest.

4. Wallowa-Whitman National Forest.

5. Malheur National Forest.

6. Deschutes National Forest.

7. Winema or Fremont National Forest.

10/ Mowat, Edwin L. 1961. Growth after partial cutting of ponderosa pine on permanent sample plots in eastern Oregon. Pacific N. W. Forest & Range Expt. Sta. Res. Paper 44, 23 pp., illus.

11/ Northwest Forest Pest Action Committee. 1953. An evaluation of forest insect and disease research needs in Oregon and Washington. Part I - Insects. 27 pp.

B. Study areas will be sought which represent both thinned and unthinned conditions (or lightly and heavily stocked conditions).

C. Study areas will be sought where the following species compositions exist.

1. Pure ponderosa pine.

2. Mixed ponderosa pine and lodgepole pine.

3. Mixed ponderosa pine, white fir, and Douglas-fir.

D. Study areas will be sought where an overstory is present and absent.

E. To be suitable an area must be of at least 25 acres and of similar characteristics over its whole.

F. Suitable areas will be delimited on one-inch-to-the-mile maps. The maps will be brought to Portland in the fall for use in the final selection of study areas.

MISCELLANEOUS ACTIVITIES

Listed below are several miscellaneous activities which will be undertaken, if and when time permits:

M-1. Bark Beetles in Windthrown Ponderosa Pine and Lodgepole Pine.

Data will be collected on bark beetle species attacking windthrown pines and their distribution along the boles of the trees.

M-2. Service of K. H. Wright's Cone and Seed Insect Rearings.

K. H. Wright will be conducting some exploratory studies of the cone worms attacking second-year ponderosa pine cones. The work will require some routine rearings to be set up at Pringle Falls. The author will assist in servicing these rearings from time to time.

M-3. Use of "Tanglefoot" to Capture Bark Beetles.

It will be determined if a bark beetle landing on "Tanglefoot" is readily captured and retained by the material. Whether "Tanglefoot" attracts or repels various species of bark beetles will also be investigated.

M-4. Chipped Slash as Source of Attraction for Oregon Pine Ips.

Observations will be made to determine if Ips oregoni is attracted to chipped slash or to trees near chipped slash.

M-5. Use of Spray-Paints in Marking Bark Beetles.

The use of spray-paints of different compositions to mark bark beetles will be investigated. Information will be gathered on rate of drying, effects on beetles, etc.

REPORTING

At the conclusion of the field season, the project data will be analyzed and presented in a progress or office report by Sartwell. The report is to be completed by December 31, 1963.

PERSONNEL

The author will do the detailed planning, the bulk of the field work, and prepare a report on the studies described in this work plan. Broad planning, general guidance, and some field assistance will be provided by K. H. Wright, Project Leader. A seasonal assistant, M. C. Fenning, will assist on some of the field studies. Time spent on the studies by these individuals and secretarial help is estimated to be as follows:

C. Sartwell, Jr.		
Planning	2	man-months
Collection of field data	4	"
Analysis and reporting	1	"
K. H. Wright	1	"
M. C. Fenning	1	"
Secretarial	1/2	"
Total	9-1/2	man-months

STUDY COSTS

Estimated direct costs to project funds are as follows:

Salaries	
Permanent personnel	$3,810
Temporary personnel	160
Per diem	480
Auto expenses	410
Equipment, materials, supplies	60
Total	$4,920

COOPERATION

The Bend Silvicultural Laboratory, Pacific Northwest Forest and Range Experiment Station, will provide lodging and laboratory space at Pringle Falls Experimental Forest headquarters, and will make available a nuclear-probe soil moisture instrument.

The Statistical Services Section, Pacific Northwest Forest and Range Experiment Station, will assist in the analysis of data obtained this season.

National Forest Administration and Bureau of Indian Affairs personnel will assist in locating suitable study areas for the long-term mountain pine beetle study and in maintaining seasonal history rearings in areas where it is not feasible for the project entomologist to provide weekly maintenance of the rearings.

EQUIPMENT

Following is a list of equipment needed for field work which will be furnished by the Division of Forest Insect Research:

1	automobile, 1958 Chevrolet station wagon, G2-520
1	stereomicroscope
1	tatum, aluminum, 10"x12"
2	tatums, aluminum, 6"x9"
1	bow saw, with extra blade
2	axes
1	hatchet
1	increment borer
1000	gelatin capsules
200	vials and corks
10	springs, dendrometer
60	boxes, cardboard, unassembled, for cages
60	jars, pint, with 2-piece lids
1	tape, diameter
6	tape, adhesive, rolls of
1	compass, hand
1	lamp, table
1	heater, portable, electric
1	ladder, wood, 12 feet
10	cages, screened
6	paint, pressurized can, pint, assorted colors
30	thermometers, glass, tubular, range -40°F. to 212°F.
1	hygrothermograph
1	shelter, hygrothermograph
3	gages, oleoresin exudation pressure
3	Tanglefoot, quart jars
1	bark punch, rectangular
2	tally registers
1	pruning snips
2	hats, safety
1	camera, 35 mm
1	camera, 4x5
1	cotton, pound of
1	banding, aluminum, roll of

WORK SCHEDULE

April 1-15:

1. Determined I. oregoni overwintering sites and stages in Pringle Falls, Wildhorse Creek, and Canyon Creek areas.
2. Determined D. monticolae overwintering stages in Pringle Falls area.
3. Determined sex ratio of overwintering I. oregoni population in Pringle Falls area.
4. Checked for flight of overwintered I. oregoni adults in Pringle Falls, Wildhorse Creek, and Canyon Creek areas.

April 16-30:

1. Determined I. oregoni overwintering stages and sites in Calamity Butte area.
2. Checked for flight of overwintered I. oregoni adults in Pringle Falls, Canyon Creek, and Calamity Butte areas.
3. Checked development of D. monticolae in Pringle Falls area.

May 1-15:

1. Worked on study plan.
2. Checked for flight of overwintered I. oregoni adults in Pringle Falls and Canyon Creek areas.

May 16-31:

1. Checked for flight of overwintered I. oregoni adults in Pringle Falls, Canyon Creek, and Hehe Butte areas.
2. Checked development of I. oregoni in Pringle Falls, Canyon Creek, and Hehe Butte areas.
3. Checked development of D. monticolae in Pringle Falls area.
4. Set up caged seasonal history rearings of I. oregoni and D. monticolae at Pringle Falls.
5. Determined attack sex ratio for overwintered I. oregoni adults in Pringle Falls area.
6. Completed first draft of study plan.

June 1-15:

1. Checked development of I. oregoni in Pringle Falls, Canyon Creek, and Hehe Butte areas.

2. Checked development of D. monticolae in Pringle Falls area.

June 16-30:

1. Submitted final draft of study plan.

2. Checked development of I. oregoni in Pringle Falls, Canyon Creek, Hehe Butte, Wildhorse Creek, and Calamity Butte areas.

3. Checked development of D. monticolae in Pringle Falls area.

4. Set up caged seasonal history rearings of I. oregoni in Canyon Creek, Hehe Butte, Wildhorse Creek, and Calamity Butte areas.

5. Made forced I. oregoni attacks to determine if the beetles can successfully attack living trees during the period of intense radial growth.

6. Determine pre-emergence and emergence sex ratio of I. oregoni first generation.

7. Initiate rearings to determine effects of sex ratio on I. oregoni attack behavior and brood productivity. (Used overwintered parent adults and first generation new adults.)

8. Survey for possible D. monticolae study sites on the Malheur and Fremont National Forests.

July 1-15:

1. Check development of I. oregoni in Pringle Falls, Canyon Creek, and Hehe Butte areas.

2. Check development of D. monticolae in Pringle Falls area.

3. Replicate forced I. oregoni attacks to determine if the beetles can successfully attack living trees during the period of intense radial growth.

4. Determine attack sex ratio of I. oregoni first generation.

July 16-31:

1. Check development of I. oregoni in Pringle Falls, Canyon Creek, Hehe Butte, Wildhorse Creek, and Calamity Butte areas.

2. Check development of D. monticolae in Pringle Falls area.

3. Determine pre-emergence and emergence sex ratio of I. oregoni second generation.

4. Set up more rearings to determine effects of sex ratio on I. oregoni attack behavior and brood productivity. (Will use first generation parent adults and second generation new adults.)

5. Survey for D. monticolae study sites on the Ochoco, Malheur, Wallowa-Whitman, and Umatilla National Forests.

August 1-15:

1. Check development of I. oregoni in Pringle Falls, Canyon Creek, and Hehe Butte areas.

2. Check development of D. monticolae in Pringle Falls area.

3. Force I. oregoni attacks to determine if beetles can successfully attack living trees after they have completed seasonal radial growth.

August 16-31:

1. Check development of I. oregoni in Pringle Falls, Canyon Creek, Hehe Butte, Wildhorse Creek, and Calamity Butte areas.

2. Check development of D. monticolae in Pringle Falls area.

3. Force I. oregoni attacks to determine if beetles can successfully attack living trees after they have completed seasonal radial growth.

4. Set up more rearings to determine effects of sex ratio on I. oregoni attack behavior and brood productivity. (Will use second generation parent adults and third generation new adults.)